

REMARKS

Applicants note with appreciation the allowance of claims 16-18, 20-24, 27-31, 34-39, 41-44, and 86-91. Claims 5, 19, 32, 33, 40, 45-49, 51, and 96 have been cancelled. Claims 1, 3, 4, 9-12, 14, 15, 25, 50, 52, 54, 56-70, 73, 82-85, 89-93, and 95 are currently amended. Claims 1-4, 6-18, 20-31, 34-39, 41-44, 50, 52-95, and 97 remain pending in the present application.

Claims 1-4, 14, 54-57, 66, 70-73, and 82 stand rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent no. 6,277,733 (Smith). Applicants respectfully traverse this rejection.

Claim 1, as amended, recites a method for removing polymer etch residue from an etched opening in a silicon wafer device comprising “forming an opening in an insulating layer, wherein a polymer etch residue remains within said opening after the opening forming step” and “contacting said opening with a first plasma to remove a portion of said polymer etch residue.” Claim 1 further recites “stopping said contacting with said first plasma before all of said polymer etch residue is removed” and “contacting said opening with a second plasma to remove the polymer etch residue not removed by said first plasma, said second plasma being generated from a gas consisting of ammonia and said second plasma being generated from a different gas.” Smith does not disclose such a method.

Smith relates to a method of fabricating an electronic device formed on a semiconductor wafer by patterning and etching a hardmask (302), photoresist removal (312), and residue removal (313). See Figure 1. Smith recites that “the wafer should be subjected to a hydrogen-containing plasma so as to remove the photoresist.” (Col. 4, lines 19-20). Smith also recites that “subsequent clean-up step (step 313) is preferably performed, . . . so as to remove any polymer that is formed on the sidewalls of the via or the trench.” (Col. 4, lines 27-30; Fig. 1). Smith further recites that “the wafer would be subjected to a plasma which contains H₂ . . . *and* CF₄.” (Col. 4, lines 34-36). Therefore,

Smith does not disclose the use of a non-ammonia plasma in a first step, followed by the use of an ammonia-containing plasma to remove polymer etch residue, as recited in claim 1. Since Smith does not disclose all the limitations of claim 1, claim 1 and dependent claims 2-4, 6-15, 25, and 26 are patentable over the reference.

Claims 54 and 70 recite limitations similar to claim 1, including, *inter alia*, “subsequently contacting said opening with a second plasma to remove the remainder of said polymer etch residue, said first plasma being generated from a gas other than a hydrogen-containing gas and said second plasma being generated from a gas consisting of hydrogen gas,” in claim 54; and “contacting [said polymer etch residue] with a first plasma and a second plasma, . . . said first plasma generated from a gas not containing hydrogen and said second plasma generated from a gas consisting of methane gas,” in claim 70. As mentioned above with respect to claim 1, Smith discloses the use of a first hydrogen-containing plasma and a second plasma containing CF_4 *in addition to an H_2 -containing compound* to remove polymer etch residue. Since Smith does not disclose first and subsequent plasma steps, a first plasma that is not hydrogen-containing *and* second plasma generated from a hydrogen-containing gas, as recited by claims 54 and 70, claims 54 and 70 and respective dependent claims 55-57, 60, 71-73, and 82 are patentable over the reference. Applicants respectfully request that the 35 U.S.C. § 102(e) rejection of claims 1-4, 14, 54-57, 66, 70-73, and 82 be withdrawn.

Claims 6-13, 58-65, and 74-81 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Smith. Applicants respectfully traverse this rejection.

Claims 6-13, 58-65, and 74-81 depend from claims 1, 54, and 70, respectively. For at least the same reasoning as set forth above regarding the patentability of claims 1, 54, and 70 as not anticipated by Smith, Smith would not have rendered the subject matter of independent claims 1, 54, and 70 obvious. Smith does not teach or suggest removing polymer etch residue using a “second plasma being generated from a gas consisting of ammonia and said first plasma being generated from a different gas,” as recited in claim 1;

“said first plasma being generated from a gas other than hydrogen-containing gas and said second plasma being generated from a gas consisting of hydrogen gas,” as recited in claim 54; or “said first plasma generated from a gas not containing hydrogen and said second plasma generated from a gas consisting of methane gas,” as recited in claim 70. Instead, the Smith process requires the use of a first gas containing a hydrogen compound and a second gas containing CF₄ compound *in addition to* the H₂ gas containing compound, which is substantially different from any of the claimed methods. Thus, Smith does not teach the claimed method and Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 6-13, 58-65, and 74-81 be withdrawn.

Claims 1, 2, 15, 25, 26, 50, 52, 53, 67-69, 83-85, and 92-97 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent no. 6,284,664 (Kawai) in view of Smith and U.S. Patent no. 6,291,890 (Hamada). Applicants respectfully traverse this rejection.

There is no motivation to combine the teachings of Kawai, Smith and Hamada. Kawai relates to a method of forming a semiconductor device including a step of removing an organic layer deposited at the bottom of the contact holes “through the use of a plasma of a mixed gas consisting of CF₄ and O₂.” (Abstract). By contrast, Smith specifically *teaches away* from the use of oxygen throughout its process. When removing “the photoresist and any polymer formed on the sides of the via or the trench, the top of conductor 420, the surface of the dielectric 430, and any remaining portions of the barriers 420 and 426,” Smith discloses that “the traditional oxygen photoresist strip *should not be performed.*” (Col. 4, lines 10-16, emphasis added). Therefore, Smith *teaches away* from Kawai and the two references should not be combined.

Hamada relates to a semiconductor device having “an improved silicide structure using a semi-insulating polycrystalline silicon film.” (Col. 1, lines 10-14). Hamada is entirely silent on “contacting said opening with a plasma to remove said polymer etch residue,” as recited in the claimed invention. Since Smith *teaches away* from Kawai, and

since Hamada is entirely silent on the use of plasma to remove etch residue, there is no motivation for a person skilled in the art to combine the teachings of Kawai with the teachings of Smith and Hamada.

Even assuming *arguendo* that there would have been a motivation to combine the references (which there was not), Kawai, Smith, and Hamada, even in combination, do not teach or suggest all the limitations of the claimed invention. As mentioned above, Smith does not teach or suggest removing polymer residue from a contact opening with “said second plasma being generated from a gas consisting of ammonia and said first plasma being generated from a different gas,” as recited in claim 1; “said first plasma consisting of a gas other than ammonia gas and said second plasma consisting of ammonia gas,” as recited in claim 50; “said first plasma being generated from a gas other than hydrogen-containing gas and said second plasma being generated from a gas consisting of hydrogen gas,” as recited in claim 54; “said first plasma generated from a gas not containing hydrogen and said second plasma generated from a gas consisting of methane gas,” as recited in claim 70; “said first plasma comprising a gas not containing hydrogen gas and said second plasma consisting of hydrogen gas,” as recited in claim 92; and “an oxygen plasma . . . and . . . a methane-comprising plasma,” as recited in claim 95. The disclosures of Kawai and Hamada cannot supplement in the inadequacies of Smith in this regard. Both Kawai and Hamada are silent on removing polymer etch residue using gas consisting of ammonia, hydrogen, or methane gases.

Since there is no motivation to combine the references, and even if combined, the Kawai, Smith, and Hamada do not teach or suggest the limitations of the claimed invention, the subject matter of claims 1, 50, 54, 70, 92, and 95 and respective dependent claims 2, 15, 25, 26, 52, 53, 67-69, 83-85, 93, 94, 96, and 97 would not have been obvious over the references. Applicants respectfully request that the 35 U.S.C. § 103(a) rejection of claims 1, 2, 15, 25, 26, 50, 52, 53, 67-69, 83-85, and 92-97 be withdrawn.

Application No.: 09/653,561
Amendment dated April 14, 2004
Reply to Office action dated January 14, 2004

Docket No.: M4065.0239/P239

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

Dated: April 14, 2004

Respectfully submitted,

By



Thomas J. D'Amico

Registration No.: 28,371

DICKSTEIN SHAPIRO MORIN &

OSHINSKY LLP

2101 L Street NW

Washington, DC 20037-1526

(202) 785-9700

Attorney for Applicants